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## Application based studies

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## APPLICATION BASED STUDIES

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### Introduction

Application based studies have been conceived and developed as a contribution to the requirement for multi-disciplinary tasks to be used in education in the field of design and technology. Studies based on the framework should make a definite contribution to the realisation of the Attainment Targets published in the National Curriculum Proposals for Design and Technology.

The paper describes the two studies which have been prepared as part of the Nottingham Polytechnic/University of Lancaster Curriculum Development Project to support 'A' level Design and Technology.

### 1. Design and Technology in the National Curriculum

The Report on the National Curriculum Proposals for Design and Technology (1) states that the overall objective for the subject is to enable pupils (and therefore citizens) "to operate effectively and creatively in the made world"; and that good practice in primary and secondary schools will involve:

- (i) contexts for design and technological activity which are broad, balanced and relevant;
- (ii) within the attainment target framework, the coordination of design and technological activities currently undertaken in art and design, business studies, craft design and technology, home economics, and information technology;
- (iii) the use of knowledge, skills and understanding drawn from the core subjects of mathematics, science and english;
- (iv) attainment targets which reflect the holistic nature of design and technology;
- (v) the description in programmes of study of a core of knowledge, skills and values as resources to be used in design and technological activity.

The National Curriculum Proposals provide attainment targets and programmes of study which aim to ensure that pupils develop the ability to:

- (i) intervene purposefully to bring about and control change;

- (ii) speculate on possibilities for modified or new artefacts, systems and environments;
- (iii) model what is required in the mind, symbolically, graphically and in three-dimensional forms;
- (iv) plan effective ways of proceeding and to organise appropriate resources;
- (v) achieve outcomes of good quality which have been well appraised at each stage of their development;
- (vi) appraise artefacts, systems and environments created by others;
- (vii) understand the significance of design and technology to the economy and to the quality of life.

The attainment targets and programmes of study are intended to assist and encourage the coordination of the knowledge, skills and values necessary for design and technological activities and to be found at present in art and design, business studies, craft design and technology, home economics and information technology. The Report emphasises the need for ways and means to stimulate the levels of collaboration needed to achieve the aims outlined above.

Application based studies have been conceived as a means of bringing about collaboration of specialist teachers through involvement with a comprehensive, cross-curricula investigation into the design, manufacture, marketing, and use of a product, system, or environment. These studies can provide a basis for instruction in, and awareness of, each of the areas listed in the programmes of study for all ten levels of attainment in the National Curriculum Proposals: materials and components, energy, business and economics, tools and equipment, aesthetics, systems, structures, mechanisms, exploring and investigating, imaging and generating, modelling and communicating, organising and planning, making, appraising, health and safety, social and environmental.

## **2. Application Based Studies**

An application based study is multi-disciplinary task designed to provide an opportunity for students to:

- (i) appreciate ways in which human needs have been met through the creation of products, systems and environments;
- (ii) develop critical awareness of the made world;
- (iii) acquire knowledge and understanding of resources and constraints within the context of design activities.

Each study is centred on a specific product, system or environment and considers all the factors which have contributed to the designing, making, marketing, and use of the product, system or environment. These factors are intended to be embraced by the

following schedule which provides the framework for structuring each study:

- |        |             |   |
|--------|-------------|---|
| (i)    | Need        | What need is met? User specifications.<br>Technical specifications.                                       |
| (ii)   | Competition | How do other solutions fulfil the same need?  |
| (iii)  | Economics   | Market research; expected life; scale of<br>manufacture; cost; customer reaction.                         |
| (iv)   | Legal       | Patents; registered designs; safety; liability.   |
| (v)    | Science     | Scientific concepts and understanding;<br>scientific and behavioural investigations.                      |
| (vi)   | Mathematics | Mathematical modelling.   |
| (vii)  | Materials   | Properties leading to selection; alternative<br>materials.  |
| (viii) | Devices     | Characteristics leading to selection;<br>alternative devices.   |
| (ix)   | Production  | Skills required to shape and manipulate<br>materials and devices.   |
| (x)    | Ergonomics  | Customer reaction.  |
| (xi)   | Aesthetics  | Visual impact; packaging; advertising;<br>customer reaction.  |
| (xii)  | Evolution   | With respect to each of the above factors;<br>and with respect to the product, system, or<br>environment. |

A graphical representation of this schedule is shown in Appendix I.

The interplay between, and the interdependence of, the factors must be emphasised. The graphical representation of the framework demonstrates the significance of the evolutionary aspect, -the pattern for the future depends on a sound appreciation of how we managed to reach the present. The design, manufacture, marketing, and use of the product, system, or environment are influenced by the attitudes of society, and the states of knowledge, ignorance, skills and values prevailing at the time the need is perceived and met. For example: did the need for a particular product, system, or environment exist five, twenty, fifty, five hundred, or even two thousand years ago? If so, how was the need met?; what has been the influence of work in the field of materials science?; what has been the impact of health and safety legislation?

### 3. Specific Studies

The concept, development, and production of the initial application based studies formed a major part of the Nottingham Polytechnic / University of Lancaster Curriculum Development Project to support 'A' level Design and Technology, (Appendix II). Although the two

studies described in the following sections have been prepared for students of the subject at 'A' level, the concept can be adapted to the full range of educational experience from the early years of primary school to undergraduate courses.

Each study has been structured to provide a range of assignments to make the use of the study an active learning process. Through the use of the studies students will recognise the need for integration of a cross-disciplinary character. The implementation of tested relevant technical knowledge within an aesthetically appealing package, marketed with due consideration to legal constraints at an acceptable cost is seen to be essential for success.

The studies take the form of a set of student assignments, plus a commentary for teachers providing background information on the product (system or environment) and on each of the assignments.

### 3.1 The Foot Pump

The foot pump is an instructive example of the impact brought about by the introduction of plastics. The design of the pump has changed significantly as metal parts have been replaced by parts made from plastics; the changes in detail design reflecting the different properties of the materials employed. The important ergonomic issue of stability of the pump has been achieved in one case by the use of a flexible plastic foot which clips into the base frame, and in another case by the incorporation of four integral protruding feet.

The publicised use of a foot pump by a medical practitioner in connection with an inhaler led to the marketing of a nebuliser, the foot pump component of which is made largely in white plastic and incorporates a ptfе sealing ring in place of the greased 'O' ring. A well known foot pump is now sold in a box on which is printed 'not to be used for medical purposes'!

The design of the packaging, and the nature of the illustrations and information on the surface of the package and in the instruction leaflet are clearly considered by the manufacturer to be of major significance.

A number of the assignments in the foot pump study reflect the need for a supply of pressurised air by man over the centuries.

#### Assignments

- (a) Draw up a product specification for means of inflating car tyres. Propose, at the conceptual level, a number of ways of meeting your specification.
- (b) Comparison of number of foot pumps, giving particular attention to materials, detail design features, and likely methods of producing the parts.

- (c) Practical and theoretical relationships between the force exerted by the foot and the pressure in the cylinder.
- (d) Analysis of the mode of operation of the pressure gauge.
- (e) Devise a method of checking the accuracy of the pressure gauge.
- (f) Prepare a brochure to be used for advertising purposes which lists all the unique selling points of the product.
- (g) Compare the packaging used for a variety of pumps, and prepare your own version of an appropriate package.
- (h) The kinematics of the mechanism.
- (i) A comparison between the functions and designs of a bicycle pump and an air-bed inflator.
- (j) Prepare a prototype device to use surface water to provide compressed air in a tin mine.
- (k) Determine the operating principles and build a working model of a Madagascan air pump.
- (l) Build a working model of a machine to supply air under pressure using a head of water as the source of energy.
- (m) Costing exercise based on the production and marketing of a pump.
- (n) Study of an actual patent specification.
- (o) Proposals for alerting a vehicle driver to an under-inflated tyre. Functioning and location of the valve in a car wheel.
- (p) Identification of the plastics materials used in a foot pump.
- (q) Calculations on the strengths of the barrel and frame.
- (r) Determine the number of strokes required to raise the pressure in a car tyre.

### 3.2 The Personal Cassette Player

The personal cassette player is a product of the last ten years and grew out of the need to play cassette tapes on the move. Sony of Japan was the innovator of the personal stereo and its 'Walkman' logo has become as widely used to indicate a personal cassette player as 'Biro' and 'Hoover' have to represent ball point pens and the vacuum cleaner.

The personal cassette player is a highly developed mechatronic product, embracing an electric motor, a tape head, an interlocking button mechanism, an electronic amplifier, a speed control system, and an injection moulded case.

Aesthetic considerations play a major part in the design of the case, the packaging, and the box in which the cassette player is displayed on the shelves in the retailing outlets.

## Assignments

- (a) Devise methods of measuring the forces to operate the pushbuttons.
- (b) Make a model of the pushbutton interlocking system.
- (c) Prepare an historical study of the changes in design; uses of materials; and production techniques.
- (d) Find out why records were the main medium for recorded sound during the first half of this century, despite the fact that magnetic recording was patented in the 1890s.
- (e) Identify the key factors influencing costs.
- (f) Design a player for a disabled person having limited use of the hands.
- (g) Exercises involving the design of the packaging.
- (h) Examine some of the legal issues associated with tape recording, eg. 'copyright'; the campaign to impose a 10% levy on blank tapes.
- (i) Compare the magnetic properties of the tape head and tape.
- (j) Examine the differences between the various tapes on the market.
- (k) Build an amplifier using an op. amp. to enable the cassette player to drive a loudspeaker.
- (l) Investigate the variation in motor speed with change of supply voltage.
- (m) Identify 'unknown' sine waves recorded on a tape, and use them to calculate the gain of the amplifier and the frequency response of the system.
- (n) Produce a circuit design for the amplifier by working backwards from the printed circuit board.
- (o) Explain 'Dolby noise reduction', 'graphic equaliser', and 'auto stop'.
- (p) Measure the frequency response of the amplifier.
- (q) Devise methods of measuring the torque on the take-up spool.
- (r) Measure the power output.
- (s) Devise methods of measuring the tape speed.

## 4. Using the Studies

The authors recommend that each study is used as a learning/teaching resource in the following manner:

- (i) Introductory talk by the teacher on the product, system, or environment, and on the assignments. [This should follow a short course on 'product development' applicable to all application based studies.]
- (ii) Work on each of the assignments by students (working singly or in pairs as appropriate) leading to the preparation of a five-minute talk supported by illustrations and models.
- (iii) Presentation of each talk to the whole group.
- (iv) Concluding talk by the teacher emphasising the need to synthesise the issues raised by the individual assignments.

## 5. Conclusion

The authors claim to have devised a framework for studies which can be structured to meet the requirements of pupils from the early years of primary school education to undergraduate courses. Plans have been made which should lead to the development of a range of studies able to meet many of the challenges of the Attainment Targets in the National Curriculum Proposals. In addition further studies to support the needs of 'A' level students will be prepared.

## Acknowledgment

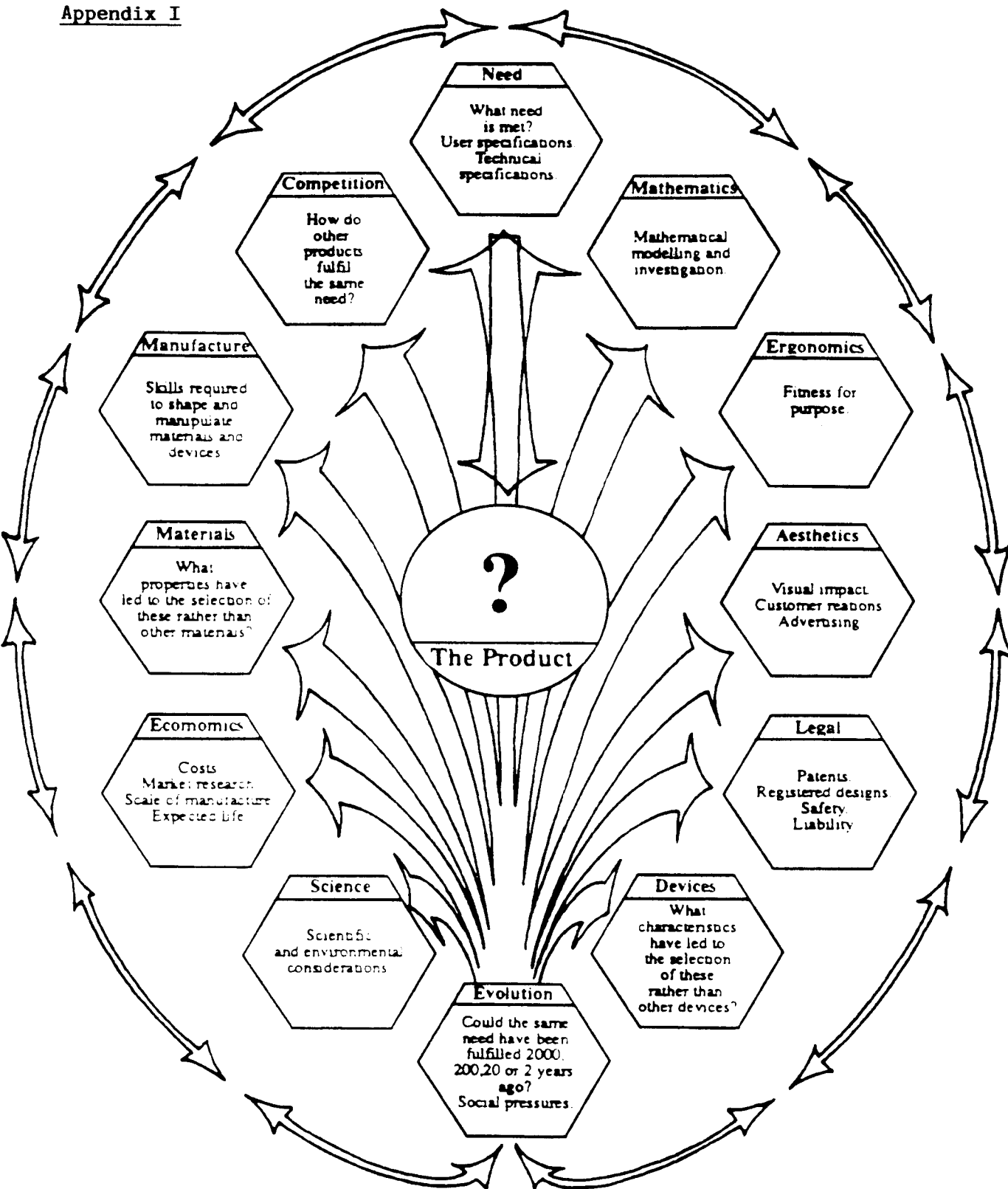
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## Reference

- 1 Department of Education and Science, National Curriculum Proposals: 'Design and Technology for ages 5 to 16', June 1989.



## Appendix I



### APPLICATION BASED STUDIES

#### A Graphical Representation of the Framework

## Appendix II

### NOTTINGHAM POLYTECHNIC / UNIVERSITY OF LANCASTER

#### CURRICULUM DEVELOPMENT PROJECT TO SUPPORT

#### 'A' LEVEL DESIGN AND TECHNOLOGY

In 1986 British School Technology-Trent, now incorporated in the Trent International Centre for School Technology (T.I.C.S.T.) at Nottingham Polytechnic, commissioned the University of Lancaster to host a curriculum development project to prepare resources to support students and teachers of 'A' level design and technology subjects. The Project, which ran from 1986 to 1989, involved the departments of Engineering and Educational Research in the University, and was directed by John B.Reynolds, Deputy Director of the School of Education at Lancaster, and Peter M.Threlfall, Consultant to T.I.C.S.T. and formerly of the Faculty of Engineering in the University of Bristol.

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